

# Scan Rate: A New Metric for the Analysis of Reading Behaviors in Asynchronous Computer Conferencing Environments

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This article introduces a new computer conferencing metric called Scan Rate, which is a measure of students' and instructors' online reading speed. The term "scan" refers to the practice of either skimming through a message at an unusually rapid pace or reading a message partially and then stopping before the end is reached. It is proposed that the Scan Rate metric offers a useful way of monitoring how thoroughly students attend to the messages they read. Four analyses illustrate the utility of the metric. These reveal that (1) scan rates increase with message size, (2) students are more likely to scan the messages of their peers than messages written by their instructor, (3) students engage in scanning practices more frequently than instructors, and (4) scan rates are partially a function of class size and class configuration.

One of the key educational advantages of computer-mediated conferencing (CMC) environments is that students have access to ideas and information provided by their peers (Hammond 1999). Through CMC, learners can tap into the collective knowledge of the class. Yet we know little about how extensively students read and process online messages written by their instructor and classmates. Our lack of knowledge in this area is fundamentally tied to an absence of useful metrics for gauging reading behaviors. Unless we resort to sophisticated technologies such as eye-tracking devices, it is difficult to know how closely students attend to the notes (messages) they open on their screens. Consequently, researchers and instructors often

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have a poor sense of online reading practices and the depth and extent to which students process CMC messages.

In this article, we introduce a new measure of online reading called the Scan Rate metric and demonstrate how it can be used to analyze reading behaviors. The Scan Rate metric was designed to measure the degree to which students appear to be scanning notes (i.e., only superficially examining the notes that they open). Higher scan rates indicate that students are engaged in faster, more superficial reading practices, and lower scan rates suggest that more in-depth reading is taking place. It is proposed that scan rates may be useful for examining the effect of different instructional strategies and collaborative structures on student reading behaviors in online courses. A sudden increase in scan rate values may signal a problem that could have a detrimental effect on student learning. Thus, the Scan Rate metric may have value both as a research tool and as a practical tool for instructors.

## **Background**

A review of the computer conferencing literature reveals a variety of researcher strategies for quantifying online activity. Some of the more commonly used measures include note counts (e.g., Davie 1988; Hiltz 1988, 1994; Guzdial 1997; Hammond 1999; Vrasidas and McIsaac 1999), mean note length (e.g., Ross 1996), counts of replies over time (e.g., Ahern, Peck, and Laycock 1992; Davie 1988; Hiltz 1994), and thread sizes (e.g., Hewitt 2003, 2005; Kear 2001). Researchers have also attempted to measure reading behaviors by counting the number of messages that students open on the screen (e.g., Coates and Humphreys 2000; Guzdial 1997). However, the latter measure is problematic. As Coates and Humphreys (2000) explain, "Careful reading of all the posts in a thread and skimming through 50 posts in five minutes are . . . indistinguishable" (10). Consequently, the number of notes opened may be a highly inaccurate and misleading measure of reading activity. More precise indicators are required.

Recent research conducted by Peters (2005) suggests that student note reading practices are complex and are influenced by a wide variety of factors such as personal interest, the length of individual messages, and the number of messages that must be read within a given time period. The latter factor appears to be particularly important. Peters describes how many students report feeling rushed and overwhelmed in their online sessions. When students were asked in a questionnaire

to describe their greatest sources of frustration while reading, “Volume of Messages” was the most commonly cited item. These findings were supported by follow-up interviews. As one student commented, “[reading notes] just takes forever . . . I feel like it takes twice as long to participate without the same level of enjoyment [relative to face-to-face courses]” (Peters 2005, 38).

Despite personal perceptions of a heavy reading load, 68.4% of the learners in Peters’s (2005) study reported that they typically read between 81% and 100% of the notes contributed each week to their online courses. However, they also acknowledged that they didn’t always read these notes carefully. If a note was long (five hundred words or more), many students (64.9%) admitted that they were less likely to read the note to the end. These findings are consistent with other research that suggests skimming is a common strategy for coping with workload demands (Atack 2003; Land 2004). Some online participants scan for content that interests them while ignoring other messages (Bodzin and Park 2002). This suggests that although students may open most of the notes in a computer conferencing environment, they do not necessarily read each one in detail and are more likely to skim through the long notes.

There appear to be two diametrically opposed schools of thought regarding terms like “scanning” and “skimming.” The first school of thought views these words as high-level reading comprehension strategies (Hanson-Smith 2003). For example, Murray (2003) views skimming as a useful strategy that one might employ when trying to obtain an overview of a large body of text, whereas scanning is an effective means of locating specific content. From Murray’s perspective, skimming and scanning are operations that lead to desirable learning outcomes. Some research has suggested that up to 30% of a skilled reader’s activity can be described as skimming (Masson 1982). In a similar vein, Hoey (1991) suggests that sentence-by-sentence reading of text is typically reserved for more complex, in-depth reading tasks and does not (and should not) characterize all online reading. Some researchers have even developed supports for skimming texts online, such as tools that intelligently extract summary sentences relevant to a particular topic (Chi et al. 2005).

A second school of thought regards online skimming and scanning as coping strategies brought on by an unremitting barrage of text messages. For example, Land (2004) describes the experience of reading online text as follows:

The potentially “saturated” online reader skipping and clicking down the endless garden of forking paths encountering ever accumulating

sources of information, skimming the surface of many different texts and probably not engaging in the reading of substantial blocks of texts. (537)

From this perspective, skimming and scanning presumably lead to shallow, superficial learning.

Regardless of how skimming and scanning are interpreted, it is clear from the research to date that these processes need to be better understood. In this article, the term “scanning” is used to refer to reading practices that are unlikely to result in deep comprehension, such as reading online text quickly or reading only part of a note. A high incidence of scanning may or may not be desirable, depending on the situation and the goals of the learner. Because we are devising a purely quantitative metric, and because the reading process is not directly observable, we do not make any claims or assumptions about the cognitive processes in which students are actually engaged. Our objective, in this case, is simply to measure levels of scanning. The Scan Rate metric was developed for this purpose.

### **The Scan Rate Metric**

Research suggests that there are differences between reading text on a Cathode Ray Tube monitor (CRT) and reading text on paper (O’Hara and Sellen 1997). Early studies found that reading from a CRT monitor is 10% to 40% less efficient than reading from paper in terms of reading speed (e.g., Kruk and Muter 1984; Kurniawan and Zaphiris 2001; Mills and Weldon 1986; Muter et al. 1982). Proofreading accuracy (Gould and Grischkowsky 1984; Wright and Lickorish 1983) and comprehension (Muter et al. 1982) may also be adversely affected. These differences have been attributed to a combination of factors, such as screen resolution, spacing, size of characters, and methods of text advancement (Muter and Maurutto 1991), although the precise contribution of each factor remains unclear. However, many of these studies were conducted in the 1980s, when the quality of monitors was poorer. Improvements in screen technology are reducing these differences (Muter and Maurutto 1991). For example, Nielsen (1998) claims that with screen resolutions of three hundred dots per square inch, reading rates online can be equivalent to those of the printed page.

To establish a modern-day baseline for online reading speeds, we asked twenty-two University of Toronto graduate students to read a set of online

messages. Each of the participants was already experienced with online class discussions. The students were given the following instructions:

Read each note in the discussion completely. Read quickly, but read for understanding and comprehension. Don't skim. Once you've reached the end of a note, don't re-read it. Just read it once. Read all the notes continuously, one after the other. Don't "rest" between notes. Don't worry if you consider yourself to be a slow reader, a fast reader, or if English is your second language. We're trying to collect a wide range of reading speeds.

All messages were stored in Web Knowledge Forum, the computer-conferencing environment that is used for distance education courses at the Ontario Institute for Studies in Education. A student's reading speed for a particular note was calculated by dividing the number of words in the note by the time that a note was visible on the learner's screen. For example, if a note was visible for sixty seconds and the note contained 240 words, the reading speed was 4 words per second (wps). An average reading speed was then calculated for each student.

The mean reading speed for the baseline trial was 3.97 wps and the minimum and maximum speeds were 1.79 and 6.39 wps, respectively. These findings are comparable to those previously recorded for university students in other studies. In particular, three experiments by Muter and Maurutto (1991) found that the average reading speed of postsecondary students on a high-resolution monitor was 199–250 words per minute (or 3.3–4.2 wps). Muter and Maurutto also discovered that text comprehension began to suffer when reading speeds reached 501 words per minute (or 8.4 wps).

Given our baseline measures and the results of previous research, we operationally defined the term scanning as "a reading speed equal to, or in excess of, 8.0 words per second." For example, if a student's reading speed for a particular message is 10 wps, it is highly probable that the student skimmed over the note quickly, read only part of the note, or failed to read the note at all. Admittedly, 8.0 wps is a somewhat conservative boundary point because the negative relation between reading speed and comprehension exists on a continuum, and there is undoubtedly considerable variation across students. For many individuals, comprehension may begin to suffer at 6 wps, or even lower speeds. The value of 8.0 wps was chosen because it represents a speed at which we can say, with some certainty, that most students are scanning. It does not allow us to

make claims about the exact amount of scanning taking place, but it can be used to establish benchmarks of scanning activity and then determine how scanning practices vary under different conditions.

A Scan Rate is calculated by determining the percentage of time that a particular student spends scanning online text. For example, if a student opened one hundred notes and scanned (i.e., has a reading speed of 8+ wps) twenty-eight of those notes, the scan rate is 28%. In cases where a student opened the same note on multiple occasions, only the maximum reading time was included in the calculations. For example, if a student spent forty seconds reading Note #123 on Day 1, and then opened Note #123 again on Day 2 for five seconds, the student's reading time for Note #123 is considered to be forty seconds. It is also recognized that some reads may be accidental; a student may open a note only to realize that she has already read it. By counting only the maximum reading time in the results, we arguably gain a more accurate sense of how closely online participants are reading each individual note.

From a computational point of view, one of the advantages of the Scan Rate metric is that it finesses a problematic phenomenon in the dataset: the existence of unusually high reading speeds. High reading speeds are usually recorded when a student glances at a message and then closes it immediately. In fact, speeds in excess of 100 wps are not uncommon when large notes are viewed for only a few seconds. Because of this phenomenon, it is not possible to use a "mean reading speed" calculation to study the scanning tendencies of a student or a group, because high values disproportionately inflate the mean. To circumvent this limitation, our Scan Rate metric simply calculates the percentage of time that reading speeds exceed 8 wps. This approach is more statistically reliable and allows the exploration of conditions that give rise to higher and lower amounts of scanning.

When calculating scan rates, it is important to remember that the time a note is visible on the screen is not necessarily equal to the time that a student actually spends reading it. However, we can say, with some certainty, that "true" scan rates must be equal to or greater than the rates we calculate. For example, if a student's reading speed for a particular note is 20 wps (e.g., a one-hundred-word note is visible on a student's screen for only five seconds), then it would be virtually impossible for the student to have read the note in depth, because it was not on the screen long enough for it to be examined thoroughly. Therefore, fast reading speeds are highly indicative of scanning behaviors. Slow reading speeds, on the other hand, are not necessarily indicative of in-depth reading. For

example, another student could have the same one-hundred-word note visible on his or her screen for fifty seconds (yielding an effective reading speed of 2 wps) but spend only several seconds actually looking at the note. Thus, the scan rates produced by this metric will always be an underestimate of the true scan rate. However, the Scan Rate metric does allow us to determine a lower bound on the amount of scanning and to study changes in scanning behaviors over time, or between different groups of people, or under different conditions.

### **Scan Rate Questions**

To illustrate the utility of the Scan Rate metric, we show how the metric can help answer the following research questions about student and instructor reading practices:

1. Is there a relationship between students' tendency to scan notes and the size of the notes they read?
2. Do students scan the instructor's notes more or less frequently than they scan the notes of their peers?
3. To what degree do instructors scan notes? Do they scan notes at the same rate as students?
4. What is the difference in student scan rates for courses that use whole-class discussions and those in which students have discussions in small groups?

### **Data Source**

In general, it is difficult to analyze the reading practices of students in computer-conferencing courses. Reading is an internal process and is therefore not easily studied. In addition, there exists a natural variation in reading habits among students, and a wide range of course-related factors—such as class size, course content, the instructor's instructions, and assignment structures—can also affect reading behaviors. Because of this variation, a large number of courses must be analyzed to detect broad trends in student scanning practices.

Accordingly, a set of thirty-seven online courses was selected for this study. All courses were offered by the Ontario Institute for Studies in Education at the University of Toronto between 2003 and 2005. Fourteen different instructors taught the courses, all of which took place in a Web-based, asynchronous threaded discourse environment called Web

Knowledge Forum. Each course was a “pure” distance education course in the sense that students did not meet face-to-face as a class, and all of the coursework took place online. Class sizes ranged from five to twenty-one students. Of the thirty-seven courses, twenty-five were whole-class discussion courses in which the entire class worked in a common discussion area each week. In five of the thirty-seven courses, student discussions took place entirely in small groups. The remaining seven courses used a mixture of whole-class and small-group discussions.

Scan rates were computed for every student in each class. Only notes that were read exclusively online were included in the data analysis. The conferencing system software kept track of those occasions where notes were grouped together in a single list for printing purposes. Notes printed and then read off-line were necessarily excluded.

### **Question 1: Typical Course Scan Rates**

*Is there a relationship between students’ tendency to scan notes and the size of notes they read?*

Table 1 displays the reading speeds of different size notes by students in the thirty-seven courses. For example, the fifth line of Table 1 shows that across the thirty-seven courses, there were a total of 22,289 occasions in which a student read a note that contained between 100 and 124 words. In 43.4% of these cases, students read these notes at a reading speed of 4 wps or slower. In 23.8% of these cases, students had a reading speed of 4 to 6 wps. In 12.5% of these cases, students had a reading speed of 6 to 8 wps. In 20.4% of the cases, students scanned notes at a rate of 8 wps or faster. This latter figure (20.4%) is the scan rate for notes that contain 100–124 words.

The data in Table 1 show that as the size of notes increases, so does the scan rate. When notes contain 475 or more words, students are scanning approximately 50% of the time. Figure 1 illustrates the relation between note size and scan rates for all note sizes between 0 and 624 words. It is evident that students are much more likely to scan longer notes than shorter notes. Thus, the longer the note, the less likely it is that students will read it thoroughly.

### **Question 2: Scanning Student and Instructor Notes**

*Do students scan the instructor’s notes more or less frequently than they scan the notes of their peers?*



**Table 1. Reading Speeds Grouped by Note Size (Scan Rates Are Displayed in Boldface)**

<b>Note Size</b>	<b>8 wps or Faster (Scan Rate)</b>	<b>6 to 8 wps</b>	<b>4 to 6 wps</b>	<b>4 wps or Slower</b>	<b>Total Reads</b>
0–24	35 ( <b>0.2%</b> )	85 (0.5%)	648 (3.8%)	16,465 (95.5%)	17,233
25–49	926 ( <b>3.6%</b> )	1,107 (4.3%)	4,177 (16.3%)	19,374 (75.7%)	25,584
50–74	2,384 ( <b>9.5%</b> )	2,175 (8.7%)	5,575 (22.2%)	14,980 (59.6%)	25,114
75–99	3,673 ( <b>14.9%</b> )	2,757 (11.2%)	5,852 (23.8%)	12,343 (50.1%)	24,625
100–124	4,538 ( <b>20.4%</b> )	2,779 (12.5%)	5,315 (23.8%)	9,657 (43.4%)	22,289
125–149	4,686 ( <b>24.8%</b> )	2,441 (12.9%)	4,476 (23.7%)	7,258 (38.5%)	18,861
150–174	4,540 ( <b>27.0%</b> )	2,192 (13.1%)	3,870 (23.1%)	6,183 (36.8%)	16,785
175–199	4,142 ( <b>32.5%</b> )	1,891 (13.9%)	3,095 (22.7%)	4,523 (33.1%)	13,651
200–224	3,642 ( <b>32.5%</b> )	1,486 (13.3%)	2,483 (22.1%)	3,603 (32.1%)	11,214
225–249	3,249 ( <b>35.4%</b> )	1,162 (12.7%)	1,928 (21.0%)	2,835 (30.9%)	9,174
250–274	2,856 ( <b>36.8%</b> )	969 (12.5%)	1,577 (20.3%)	2,354 (30.4%)	7,756
275–299	2,462 ( <b>39.7%</b> )	758 (12.2%)	1,219 (19.7%)	1,758 (28.4%)	6,197
300–324	2,063 ( <b>39.0%</b> )	743 (14.0%)	969 (18.3%)	1,521 (28.7%)	5,296
325–349	1,869 ( <b>41.6%</b> )	561 (12.5%)	818 (18.2%)	1,240 (27.6%)	4,488
350–374	1,681 ( <b>42.8%</b> )	443 (11.3%)	722 (18.4%)	1,084 (27.6%)	3,930
375–399	1,255 ( <b>44.1%</b> )	331 (11.6%)	509 (17.9%)	750 (26.4%)	2,845
400–424	1,226 ( <b>45.4%</b> )	317 (11.7%)	441 (16.3%)	719 (26.6%)	2,703
425–449	1,101 ( <b>47.8%</b> )	247 (10.7%)	356 (15.5%)	599 (26.0%)	2,303
450–474	969 ( <b>46.7%</b> )	236 (11.4%)	314 (15.1%)	556 (26.8%)	2,075
475–499	969 ( <b>51.1%</b> )	197 (10.4%)	284 (15.0%)	447 (23.6%)	1,897
500–524	748 ( <b>49.3%</b> )	171 (11.3%)	233 (15.3%)	366 (24.1%)	1,518
525–549	619 ( <b>48.4%</b> )	159 (12.4%)	205 (16.0%)	296 (23.1%)	1,279
550–574	599 ( <b>52.1%</b> )	140 (12.2%)	156 (13.6%)	254 (22.1%)	1,149
575–599	464 ( <b>54.0%</b> )	76 (8.8%)	127 (14.8%)	192 (22.4%)	859
600–624	467 ( <b>51.9%</b> )	91 (10.1%)	130 (14.4%)	212 (23.6%)	900

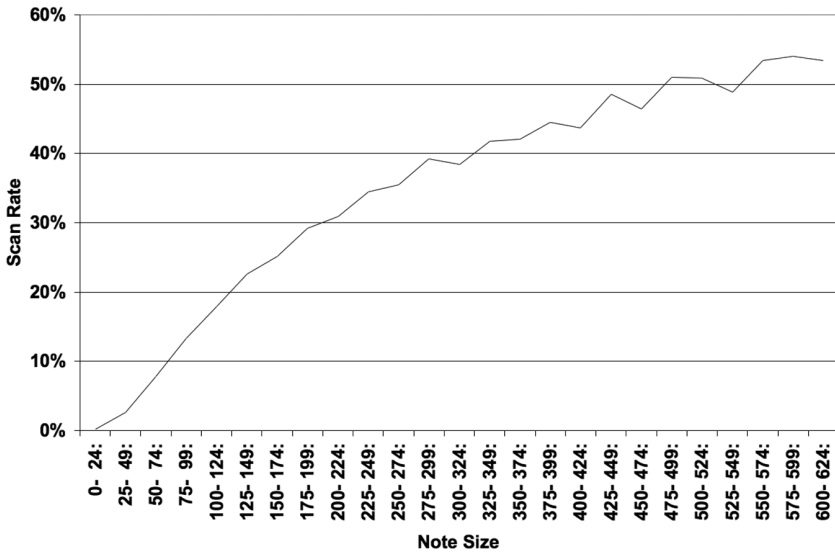


Figure 1. Scan Rates (8 wps or Faster) by Note Size.

Figure 2 illustrates two sets of scan rates. The upper line represents the percentage of scanning that occurs when students read their peers’ notes. The lower line represents the percentage of scanning that takes place when students read notes written by their instructor. The graph suggests that students are less likely to scan their instructors’ notes than those of their peers.

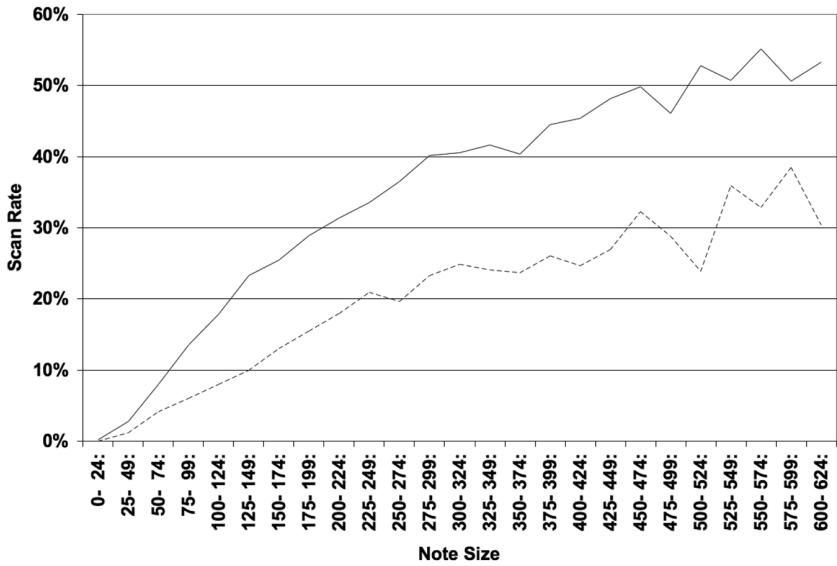
Paired *t*-tests were used to compare the mean scan rates at each note size interval. Highly significant differences ( $t \geq 3.7, p < .001$ ) were found at all intervals except for notes in the 575–599 word range ( $t = 2.278, d.f. = 101, p < .05$ ), which was significant at the .05 level.

### Question 3: Instructor Scanning Practices

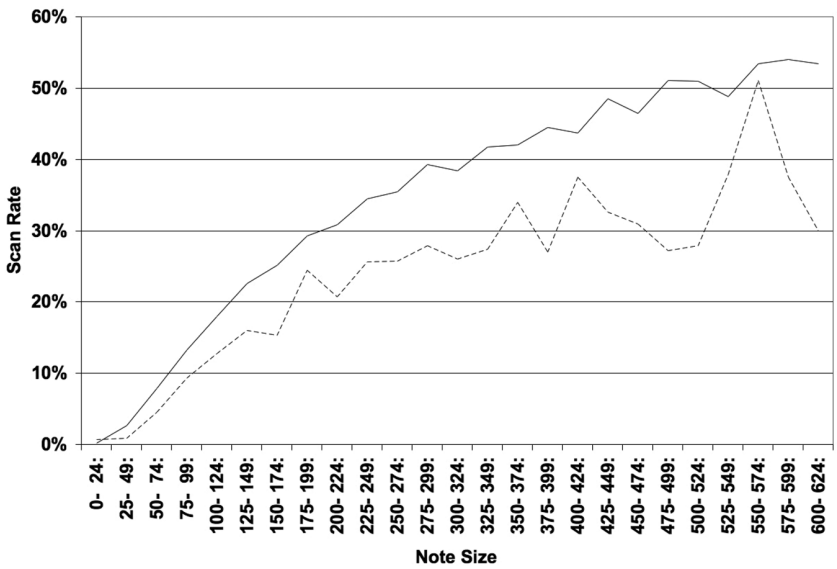
*To what degree do instructors scan notes? Do they scan notes at the same rate as students?*

Figure 3 illustrates the tendency of both students (upper line) and instructors (lower line) to scan notes when reading. Instructors appeared to scan students’ notes less frequently. In other words, instructors seemed to read students’ notes more carefully and thoroughly than students did.

Independent sample *t*-tests were conducted to determine whether instructor scan rates differed significantly from student scan rates.



**Figure 2.** A Comparison of Student Scanning Rates When Reading Notes Written by Peers (Solid Line) and Notes Written by Instructors (Broken Line).



**Figure 3.** A Comparison of Student Scan Rates (Solid Line) and Instructor Scan Rates (Broken Line).

Because there was high variability in scan rates within individual note ranges, the ranges were combined into two categories: one for notes containing 300 words or more and one for notes containing fewer than 300 words. In the large-note condition ( $\geq 300$  words), the differences between instructor scan rates ( $n=36$ ) and student scan rates ( $n=516$ ) were highly significant ( $t=3.29$ ,  $d.f.=550$ ,  $p<.001$ ). A similar test conducted on smaller notes ( $<300$  words) also found significant differences ( $t=2.459$ ,  $d.f.=553$ ,  $p<.05$ ) between the scan rates of instructors ( $n=37$ ) and the scan rates of students ( $n=518$ ). Students had consistently higher scan rates, and the differences were more pronounced with larger notes.

#### **Question 4: Scanning Practices in Groups of Different Sizes**

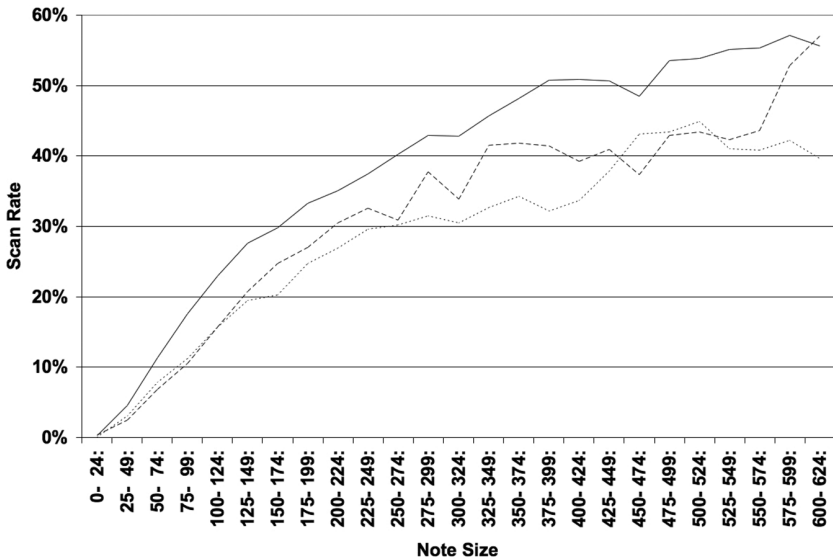
*What is the difference in student scan rates between courses that use whole-class discussions and courses in which students have discussions in small groups?*

To determine whether a relation exists between scanning and group size, the courses were divided into three groups:

- A large-class condition consisting of the ten largest classes (containing fifteen–nineteen students) where students engaged only in whole-class discussions;
- A small-class condition consisting of the ten smallest classes (containing five–ten students), which were also engaged only in whole-class discussions; and
- A small-group condition consisting of five classes (containing fifteen–twenty-one students) in which students were divided into small groups of three to six students for discussions.

Figure 4 displays the scan rates of the large-class condition (solid line), small-class condition (dashed line), and small-group condition (dotted line). Overall, the large-class condition appears to have the highest scan rate.

An independent samples  $t$ -test of notes containing 300 or more words found significant differences ( $t=2.022$ ;  $d.f.=245$ ,  $p<.05$ ) between the scan rates of students in large classes ( $n=169$ ) and small classes ( $n=78$ ). The scan rates of students in large classes ( $n=169$ ) were also significantly different ( $t=2.362$ ;  $d.f.=263$ ,  $p<.05$ ) than the scan rates of students in the small-group condition ( $n=96$ ). However, there were no significant



**Figure 4.** A Comparison of Large-Class Scan Rates (Solid Line), Small-Class Scan Rates (Dashed Line), and Small-Group Scan Rates (Dotted Line).

differences between students in the small-class condition and the small-group condition.

An independent samples *t*-test of notes containing fewer than 300 words found no significant differences between the three conditions. However, the differences in scan rates between students in large classes ( $n=169$ ) and students in the small-group condition ( $n=96$ ) is weakly significant ( $t=1.943$ ,  $d.f.=263$ ,  $p=.053$ ). If the assumption of equal variances between conditions is relaxed, the differences become statistically significant ( $t=2.129$ ,  $d.f.=250.157$ ,  $p < .05$ ).

In general, the large-class condition had significantly higher scan rates than both the small-class condition and the small-group condition when note sizes were large and may have higher scan rates than the small-group condition for shorter notes as well. These findings may be explained by differences in workload. Students in the large-class condition had more notes to read than students in the small-class condition because of the greater number of online participants. Students in the small-group condition could confine their interactions to a limited number of group-mates, causing their reading load to be relatively light. It is hypothesized

that students in the large-class condition responded to their higher reading load by scanning more frequently.

### **Summary of Analyses**

The analyses suggest a number of factors are related to online contributors' tendencies to scan notes. These factors include note size, the status of the person doing the scanning (instructor or student), the status of the person whose note is being scanned (instructor or student), and the size and configuration of the class. Students appear to do more scanning in large classes than they do in small classes or in classes that are divided into small groups.

### **Conclusions**

The preceding analyses present some sample research applications of the Scan Rate metric. It is proposed that the Scan Rate metric may be an even more powerful research tool if used in conjunction with qualitative measures of normative reading practices. It is important to emphasize that scanning is not intrinsically problematic and may be more appropriate in some classroom situations than others. For example, in situations that call for a directed search for specific information, scanning may be an appropriate strategy. It is argued that scanning may become a concern in situations in which it is used as a survival strategy to meet perceived course demands. In this regard, it may be valuable for instructors to have access to tools that provide them with scan rates to alert them to situations in which students may be experiencing elevated levels of anxiety or a sense of information overload.

In the past, researchers have called for more sophisticated tools for measuring online interactive processes (Anderson and Garrison 1995; Jeong 2003). It is proposed that the Scan Rate metric may be a helpful tool for researchers and instructors interested in exploring another dimension of student reading behaviors. Further research into the norms of online scan rates needs to be established before researchers can identify the point at which scanning starts to interfere with effective learning. More research also needs to be conducted to determine the validity and reliability of the Scan Rate metric. However, it is encouraging that the scanning rates observed in this article's analyses are consistent with prior research (e.g., Peters 2005; Peters and Hewitt 2005) and they are also consistent with our

intuitions of how we would expect scan rates to change—such as larger classes having higher scan rates due to an increased information load.

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